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(54) **Process for the hot regeneration and recycling in situ of worn road pavings and plant for carrying out the same.**

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Description

The present invention relates to a process by which the crust of worn road pavings is hot regenerated and recycled in situ, by utilizing again the bituminous concrete already forming said crust.

The invention also covers the self-propelled plant apt to carry out said process.

As known, wear and tear of road pavings represent a serious problem to solve, especially in the field of road maintenance of motor-ways and of city roads and highways with heavy traffic.

The harmful effects determined by traffic are particularly evident on the surface of the road coating, which is subjected both to the concentrated loads of vehicles in transit and to the direct action of atmospheric agents.

These combined actions produce severe stresses on the road coating, which in turn determine the numberless defects present on worn pavings, as cracks, losses of grip on the ground, treads and strains.

These defects and tears, if neglected, subsequently determine increasingly serious phenomena of deterioration, which end up by involving the whole road superstructure.

It is hence in the interest of the Administrations in charge of road care to intervene with scheduled maintenance works, to keep up a constantly acceptable road service and to prevent wear and tear of the structural features of the whole paving, while guaranteeing permanent and acceptable conditions of safety and comfort for the road traffic.

Various systems for repairing lumpy road surfaces are already known in the technique of road pavings.

From a historical point of view, said systems have developed into three different ways of proceeding:

a) Simple coating of the worn crust with an adequately thick layer (3—4 cm) of newly produced bituminous concrete, containing small size (approx. 0—16 mm) aggregates;

b) Cold removal of the torn layer and laying of a new layer as in a) hereabove, with or without using again the removed material;

c) Hot removal of the torn layer, which is regenerated in situ with the addition of bitumen and possibly of new aggregates, and is then levelled and tamped into a renewed road coating.

The solution a) is still adopted at present for road network, excluding motor-ways, and inside inhabited areas. In such cases, in fact, the drawbacks connected with an excessive overall thickness of the road coating and with its consequent minor stability, are more tolerable than those connected with a complete reconstruction of the roadway. Said solution, however, tends to be abandoned and replaced by one of the undermentioned solutions.

The solution b) has been largely adopted in the past years, especially on roads and motor-ways with heavy traffic. It has however some fundamental defects, which are now limiting its application only to roads which, owing to their characteristics of narrowness and tortuosity, do not allow an easy access to the more bulky means typical of the solution c).

In said solution b), the worn surface layer is removed through the action of a machine equipped with a rotary drum having scarifying teeth, which cold-crumbles the road surface, removing the lumpy layer. This system has the drawback of crushing the removed aggregates, thereby modifying their granulometric curve; it moreover allows only a partial recovery of the removed material, owing to the characteristics of the existing plants which, for a proper operation, require the addition of considerable percentages of "fresh" aggregates without bitumen.

Furthermore, after removal, the material has to be loaded onto lorries and transferred to the site of the plants which are designed to produce the bituminous concrete. Here, suitably mixed with new material, in a proportion varying between 30—50%, through a firing, bituminization and mixing process, it again acquires the characteristics proper to a newly produced bituminous concrete. At this point, it must evidently be retransferred on the site of use and laid with the normal finishing machines.

Of course, although this process is innovating compared to the traditional repaving of the solution a), it has serious drawbacks, and thus quite high additional burdens, owing to the total lack of total reuse of the removed materials having to be replaced by the new ones, owing to the high number and variety of working cycles to which said materials have to be subjected, owing to the high incidence in the costs for transporting said materials between the roadyard and the plants for producing the recycled concrete, and finally owing to the great inconveniences caused to traffic by the various transport means required.

The solution c) is finally that being considered as the most appropriate for use on roads of wide dimensions and heavy traffic. It in fact involves the use of a single self-propelled plant, having to be supplied with new materials only to a limited extent, considering that the hot-removal does not crush the aggregates and hence keeps unaltered the granulometric curve of the starting bituminous concrete. The works can be totally carried out on a single lane, thus notably limiting, as far as time and space, the obstacles to the traffic of normal vehicles.

The considerable cost and dimensions of these plants are largely compensated by the high economies obtained in the full recovery of the residual bituminous concrete of the worn road coating, in the high laying speeds and in the very limited use of auxiliary means, which are only required to supply materials of new use.

This last solution has up-to-date been adopted for a great number of accomplishments, which can however be combined into two main groups. A first group in which the removed material is lifted from the roadway, to be worded out anew

and integrated inside one or more devices of the plant, and to be subsequently laid again and leveled on said roadway. A second group in which all the working process takes place directly on the roadway.

Among the processes belonging to said first group, one may cite those described in the Patent CH-A-586789 (SCHOELKOPF), the Patent DE-A-2850344 (WIRTGEN) and the Patent US-A-4347016.

The Swiss Patent simply provides for the plant which recycles the removed bituminous concrete to be mounted on self-propelled means. The worn bituminous concrete, removed by known means, is worked out anew in said movable plant with the addition of an asphaltic concrete, and then laid out again on the road surface by conventional means.

In the German Patent, the worn surface layer is heated, milled, collected at the centre of the lane being worked by a cylinder with two convergent screws, conveyed into a mixing drum, mixed with the integrating material and newly laid on the roadway for subsequent levelling and tamping. It should be noted that, according to this process, heating is carried out partly in front of the milling cutter and partly behind it, just to increase the temperature of the removed material in order to favour its subsequent mixing inside the drum. It is hence an average temperature and low penetration heating. The milled material therefore suffers from the drawbacks of "cold" milling, particularly for what concerns the variation of the granulometric curve of the aggregates.

In Patent US 4 347 016 the worn surface layer is heated through a microwave heating unit. This unit is powered by a fuel operated generating unit through a power line extending along the length of the moving plant. Additional aggregate is added on the heated layer ahead of a pavement removing unit. The softened pavement, along with the added material, is removed from the road, conveyed to a second microwave unit, heated, mixed in a rotary drum and finally delivered to a paver for the application of a new layer of pavement of the road surface.

Among the processes belonging to the second group, one may cite those described in the Patent DE-A-2758601 (JEPPSON) and in the European Patent application No. 81194 (SCHOELKOPF).

The German Patent describes a recycling plant utilizing as heat source an electronic microwave system. Some of the different embodiments illustrated therein provide for the mixing in situ carried out by the actual scarifying tools, with consequent easy forming of canalizations of the removed material. The heating is low (T 100°C) and this causes the problem of the aggregates getting crushed by the scarifying blades, with consequent variation of the granulometric curve. The device anyhow requires very high quantities of energy and is thus used mainly for repairing single road sections or patches, which are particularly worn. There is no possibility to add integrating aggregates.

The European Patent application describes a process in which the worn road coating is heated by a set of radiating panels and scarified by fixed blades. The removed material is mixed on site with simultaneous addition of integrating material and is then levelled and tamped with traditional methods. The mixing operation is carried out by means of a linear set of several mixing arms (3 in the drawing), positioned in the running direction of the machine and alternately moving sideways, in order to cover the whole width of the working area.

For what concerns the processes of the first group, it should be noted that carrying away the removed material from the roadway leads to cooling of this latter, so that when the newly worked bituminous concrete is laid, the grip of this latter on the roadway is not fully satisfactory. Even though, in some cases, the road surface from which the recycling material has been removed is slightly heated, it will never be possible to obtain a perfect grip between the basic layer and the newly formed layer. In fact, there remain solutions of continuity between the two layers, which favour a faster disgregating action by atmospheric agents. Moreover, even the mechanical stresses are transmitted to the roadbed with less efficiency, thereby shortening the life of the coating.

Whereas, for what concerns the processes of the second group, it may be noted that, while on one hand the continuous working on the roadway maintains a homogeneous temperature between this latter and the material being worked, and thus guarantees a perfect grip between the basic layer and the newly laid bituminous concrete, on the other hand the addition of cold integrating material (which is usually sprayed onto the mixing units) to the removed material, makes the mixing between said two materials difficult and never fully satisfactory, with the result that the recycled coating obtained therefrom never succeeds in equalling the characteristics of newly produced coatings.

It should be noted, furthermore, that with the presently adopted heating techniques, the road coating undergoes an adequate softening (T 120°C) through a maximum thickness of only about 4 cm. The working depth cannot hence exceed said value since, in the contrary event, the scarifying tools - meeting with an exceedingly hard material - either tend to lift the whole machine from the ground (where fixed tools are used), or else crush the aggregates (when rotary tools are used). These limitations do not allow the heretofore described machines to operate successfully in all those cases (which are about 50—60% of the practical applications) wherein the cracks or deformations extend beyond the crust (3—4 cm) and also affect the underlying layer or binder.

The object of the present invention is therefore to provide an improved process which, starting from the technological results obtained by the processes belonging to the second group of the

aforementioned solution c), is apt to eliminate the above drawbacks, allowing to form a regenerated road coating having characteristics such as to make it undistinguishable from a newly constructed coating.

The object of the present invention is also, in particular, to obtain a more efficient mixing between the integrating material and the removed material, allowing furthermore to work at further depths that it has been possible to do so far, for instance down to a depth of 8 cm.

Said objects are reached, according to the present invention through a hot regeneration and recycling process in situ of worn road pavings of the type wherein the surface layer of said pavings is heated through a heat source and then scarified down, and the removed material is subsequently mixed with asphaltic concrete, integrated with the addition of aggregates, mixed again by means of mixers, levelled by moving rakes, compressed by a tamping bar and finally tamped by rolling, characterized in that the addition of aggregates is carried out at the end of the heating phase and before the scarifying operation, to heat the added aggregate by utilizing the heat excess on the coating surface; said scarifying operation is carried out by means of rotary tools; and the mixing operation between the removed materials and the aggregates is performed firstly through said rotary tools and finally through a gang of mixers alternately moving from one side to the other of the lane being worked.

Said process is preferably carried out by means of a plant characterized in that it comprises, starting from its front a first self-propelled machine providing support to move forward and operate a combustible gas tank and two sets of heating panels, and a second self-propelled machine providing support to move forward and operate a third set of heating panels, a charging hopper of the intergrating material, a tank for the asphaltic concrete, a combustible gas tank, scarifying tools in the form of a rotary cylindrical cutter, a gang of mixers for mixing the removed material with the integrating material moving alternately from one side to the other of the lane being worked, members for levelling and tamping said materials, and a charging hopper of the roughening material, and in that said charging hopper of the integrating material is positioned after the sets of heating panels and before the scarifying tools.

The process of the present invention will be described hereinafter in further detail, with simultaneous reference to a special plant apt to carry out the same, illustrated in the accompanying drawings, in which:

Fig. 1 is a diagrammatic lateral assembly view, showing an embodiment of the plant according to the invention;

Fig. 2 is a side view of a set of heating panels for the paving to be recycled;

Fig. 3 is a top view of the same set of panels;

Fig. 4 is a cross sectional view of a panel provided with heating elements;

Fig. 5 is a cross sectional view of an insulating panel;

Fig. 6 is a side view of a hopper with distributing bar.

Fig. 7 is a front view of the same hopper.

Fig. 8 is a diagrammatic side view of the scarifying and recycling machine.

Fig. 9 is a side view on an enlarged scale of the central part of said machine;

Figs. 10 and 11 are, respectively, a perspective view and a side view of the scarifying cutter; and

Fig. 12 is a side view of the pressure mechanism acting on the scarifying cutter.

With reference to figure 1, a short description is given of the different parts of the plant in the chronological order in which they start working onto a same section of road surface.

The plant first of all comprises a system for heating the road coating, formed of several sets of known type metallic panels (diagrammatically illustrated in figure 1 by one panel for each set), onto which panels are installed means for producing infrared rays, consisting for instance of a set of propane gas burners.

Mounted on idle wheels, the panels 1 (fig. 1) are driven forward by a self-propelled machine 2, which also comprises a combustible gas tank 3 feeding the burners. The same self-propelled machine 2 also tows a second set of panels 4, apt to continue heating the bituminous concrete forming the road coating to be recycled. The panels move forward, spaced by about 10 to 20 cm from the road surface to be heated.

A third set of heating panels 5 is finally driven forward by the main operating machine 6, having a scarifying and recycling function. All the sets of panels are intercalated with panels having no heating elements, but provided with an insulating and reflecting screen.

According to the process of the present invention, the integration of the aggregates contained in the paving layer to be regenerated, takes place after the heating by the sets of panels. Said integration is obtained by means of a hopper 7, driven forward by the machine 6 and positioned between this latter and the set of heating panels 5.

The machine 6 comprises a cylindrical scarifying cutter 8 working on the material forming the road paving, a plant 9 for the addition of asphaltic concrete, a gang of mixers 10 with rotating arms, and a device 11 for levelling the recycled and regenerated material, followed by a normal compactor 12.

A second hopper 7', identical to the hopper 7, can be optionally towed by the machine 6, said second hopper being designed to contain aggregates for roughening the finished road coating. In this case, such aggregates are spread out onto the regenerated surface, which subsequently undergoes an additional and final tamping by means of a road roller 13.

A more detailed description is now given of the parts forming the single elements which make up the plant. Figures 2 and 3 show part of a set of panels 1, provided with wheels 14, which move

forward driven by the self-propelled machine along the paving to be recycled. Each of the panels is articulated in 15 to the following panel and it carries the heating elements with infrared rays at a height of 10 to 12 cm from the ground. The panels have side curtains 16 (fig. 4), made of thermally insulating material and preventing outward losses of heat from the sides. As already said, some of these panels do not have elements with infrared rays producing heat, but are instead provided with a thermally insulating and reflecting screen 17 (fig. 5), which helps to keep the asphalt hot under the panel for a sufficiently long time, by reflecting heat thereon and preventing heat losses. The reflecting panels have their insulating and reflecting screen 17 (fig. 5) at a height of about 5 cm from the surface of the paving to be recycled. This arrangement favours the penetration of heat inside the road coating, simultaneously preventing the coating surface from getting overheated at temperatures which could impair the cortical part of the paving.

The length and number of the panels are calculated on the basis of the plant running speed, so that the aggregate mass included in the layer extending down to a depth of, for instance, at least 8 cm, may be subjected to a temperature increase of about 100°C in a lapse of time, reckoned as optimal, of about 30 minutes.

A pair of steering wheels is mounted between the sets of successive panels, in conventional manner, to allow the assembly to move forward on road bends.

The adjustment of the granulometric curve of the aggregates contained in the coating to be recycled is obtained, after having completed the tests on the core samples drawn from said coating, by integration with aggregates contained in the special hopper 7, better illustrated in figures 6 and 7.

Said hopper 7 comprises a rotating distributor 18, which is caused to rotate by the self-contained propelling unit 19 positioned outside said hopper, and it moves forward onto the surface previously heated at its highest temperature. The propelling unit 19 comprises an explosion engine which operates an oleodynamic pump feeding in turn a hydraulic geared motor.

The heated surface of the road coating will transmit part of its own heat to the material distributed by the hopper. In this way a double advantage is obtained: on one hand, to heat the integrating aggregate which, when getting mixed, thus reaches the most appropriate temperature for a proper working process, by utilizing the heat excess on the coating surface; on the other hand, to obtain a first very efficient mixing between the removed material and the integrating material, thanks to the subsequent action of the cutter 8 which follows.

It should be noted that this is the only method allowing to obtain an easy and efficient heating of the integrating material. Other heating systems cause a pasting of the material and make it difficult to evenly distribute the same.

The scarifying and recycling machine 6 is illustrated in figures 8 and 9. It consists of a self-propelled vehicle, for instance a tracked vehicle, which drives forward the front panels 5 and the hopper 7.

Said machine comprises a combustible gas tank 20, required to feed burners arranged inside the panels, a driving seat 21, with seats 22 for auxiliary personnel and, in the rear part, the scarifying cylindrical cutter 8, the plant 9 for adding the asphaltic concrete, the mixers 10, the rake 11 for levelling the recycled material, and the tamping bar 12. These devices are shown more clearly in figure 8 wherein, for paging requirements, the hopper 7 is not illustrated, while the set of panels 5 is shown in the folded up transport position.

It can be noted that the scarifying cutter or cutters 8 precede the rotary mixers 10, onto which drops the spray of required additional asphaltic concrete, through the pipe 27.

The rotary mixers 10 are positioned in a gang on two parallel rows, each comprising at least three and preferably four mixers and being arranged along the running direction of the machine. Said gang moves alternately from one side to the other of the lane being worked, and the left row mixers 10 (looking from the rear side of the machine) rotate anticlockwise, while the right row mixers rotate clockwise. This arrangement allows to obtain far more satisfactory mixing results than those obtained with the known technique, wherein - as already mentioned - the mixers consist of a single moving row of rotary members or comprise fixed members, and in particular it allows a perfect sharpening and trimming of the edges formed between the lane being worked and the adjacent lanes, thereby guaranteeing a perfect grip of the recycled layer also in correspondence of this particularly difficult position. The perfect trimming of the aforementioned edges can be improved even further by mounting two small vertical cutters (not shown) just downstream of the cylindrical cutter and before the mixers, which are designed to make the surface of said edges perfectly vertical.

The piston 23 (fig. 9) thrusts the scarifying cutter 8 down to the desired depth, extending at least as far as 8 cm. The use of the cutter 8, in replacement of the conventional fixed blades mounted on machines of known technique, has been made possible thanks to the particular type of heating adopted, allowing the high temperatures (120°C) to penetrate more deeply inside the road coating. This prevents the action of the cutter from causing the usual crushing effect of the aggregates, whereby the granulometric curve - as resulting from the tests on the core samples drawn from said coating - keeps perfectly unaltered.

The articulated joint 24 connects the carriage 25 - onto which are mounted the rotors of the mixers 10, the motor 26 for controlling said rotors, and the pipe 27 for spraying the asphaltic concrete - with the front part of the machine, onto which is mounted the scarifying cutter 8.

Figures 10 to 12 show some details of the scarifying cutter 8, which can be formed of a

plurality of mutually connected rollers, as 8' and 8'' in figures 10 and 11, caused to rotate by the chain 28 (fig. 11) and provided with teeth 29.

The frame 30 (fig. 12) onto which is mounted the scarifying cutter 8, is articulated in 31 and thrust downwardly to the wanted depth by the piston 23.

The levelling rake 11 acts in known manner to evenly distribute the regenerated bituminous concrete onto the road surface, and it is followed by the tamping bar 12 which provides for the final settlement of the new recycled coating.

Said coating can then be subjected - as already said - to the normal finishing operations, particularly roughening and rolling operations, according to the known techniques now adopted in this field.

From the above detailed description of the process and plant according to the present invention, it will have been noted how all the problems set forth in the introductory part have been brilliantly solved.

In fact, the heretofore described process allows to obtain:

a pre-heating of the integrating material by utilizing the heat excess of the surface coating layer which has just been heated, simultaneously preventing the problems deriving from the mixing of hot removed material with cold integrating material, and the drawbacks connected with the handling of a pre-bituminized and previously heated integrating material;

a closer mixing between integrating material and removed material, obtained thanks to the evenness of temperatures reached and to the mixing action of the cylindrical cutter which acts simultaneously on the two materials, and finally thanks to the gang of mixers which has been arranged downstream of the cutter;

finally, the technical possibility to use a rotary cutter, instead of the conventional scarifying tools with blades, thanks to an improved heating process allowing to soften the coating down to a depth of at least 8 cm. In this case, the action of the cutter causes no crushing of the aggregates and thus by no means alters the granulometric curve of the removed material. It is just worth while underlining that the use of a rotary tool, instead of a fixed tool, makes the operation more efficient, allows a higher operating speed, and fully eliminates the defects normally connected with said fixed tools, such as sticking and lifting of the machine, breakaway of bituminous concrete crusts and the like.

The invention has been described with reference to a particular embodiment and to a specific plant, but it is evident that there may be other embodiments differing from the one illustrated, while maintaining the fundamental principles to provide for the distribution of the integrating material before the scarifying operation and to provide for the scarifying tools to be rotary instead of fixed tools, without thereby departing from the scope of the invention as defined in the claims.

Claims

1. Process for the hot regeneration and recycling in situ of worn road pavings, of the type wherein the surface layer of said pavings is heated through a heat source and then scarified down, and the removed material is subsequently mixed with asphaltic concrete, integrated with the addition of aggregates, mixed again by means of mixers, levelled by moving rakes, compressed by a tamping bar and finally tamped by rolling, characterized in that the addition of aggregates is carried out at the end of the heating phase and before the scarifying operation, to heat the added aggregate by utilizing the heat excess on the coating surface; said scarifying operation is carried out by means of rotary tools (8); and the mixing operation between the removed materials and the aggregates is performed firstly through said rotary tools (8) and finally through a gang of mixers (10) alternately moving from one side to the other of the lane being worked.

2. Process as in claim 1, wherein the scarifying operation extends down to a depth of at least 8 cm.

3. Process as in claim 1, wherein the surface layer is heated by sets of heating panels (1), intercalated with panels having an insulating/reflecting screen (17).

4. Process and in claim 1, wherein the edges of the worked lane are trimmed by two vertical cutters.

5. Plant for carrying out a process for the hot regeneration and recycling in situ of worn road pavings, of the type consisting of self-propelled devices for the heating, working, levelling and tamping of road surfaces, characterized in that it comprises starting from the front of the plant, a first self-propelled machine (2) providing support to move forward and operate a combustible gas tank (3) and two sets of heating panels (1, 4) and a second self-propelled machine (6) providing support to move forward and operate a third set of heating panels (5), a charging hopper (7) of the integrating material, a tank for the asphaltic concrete (9), a combustible gas tank (20), scarifying tools in the form of a rotary cylindrical cutter (8), a gang of mixers (10) for mixing the removed material with the integrating material moving alternately from one side to the other of the lane being worked, members for levelling (11) and tamping (12) said materials, and a charging hopper (7') of the roughening material, and in that said charging hopper (7) of the integrating material is positioned after the sets of heating panels (1, 4, 5) and before the scarifying tools (8).

6. Plant as in claim 5, wherein said sets of heating panels (1, 4, 5) consist of panels having heating elements intercalated with panels having no heating elements and provided with an insulating/reflecting screen (17) positioned at 5 cm from the ground.

7. Plant as in claim 5, wherein said mixers (10) are positioned in a gang on two parallel rows, each comprising three to four mixers and being

arranged along the machine running direction, said gang moving alternately, perpendicularly to said direction, throughout the width of the lane being worked.

8. Plant as in claim 7, wherein the mixers of the right row (looking from the rear side of the machine) rotate clockwise, while the mixers of the left row rotate anticlockwise.

9. Plant as in claim 5 to 8, comprising furthermore two vertical cutters, positioned just downstream of the cylindrical cutter (8) and in contact with the vertical edges of the adjacent lanes not being worked.

10. Plant as in claim 5, wherein said first self-propelled machine (2) is positioned between said first (1) and said second (4) set of heating panels.

Patentansprüche

1. Verfahren zum heißen Regenerieren und Wiederaufbereiten Straßendecken an Ort und Stelle der Art, bei der die Oberschicht der Decken mittels einer Wärmequelle erhitzt und dann aufgerissen wird, das entfernte Material sodann mit Asphaltbeton vermischt wird, welcher mit zusätzlichen Zuschlägen versetzt ist, dann abermals mittels Mischern gemischt wird, mit beweglichen Rechen planiert wird, mit einem Druckbalken verdichtet und schließlich durch Rollen gewalzt wird, dadurch gekennzeichnet, daß die Zugabe von Zuschlägen am Ende der Erhitzungsphase und vor dem Aufreißen erfolgt, um den zugegebenen Zuschlag durch Ausnutzen der überschüssigen Hitze auf der Decke zu erhitzen; daß das Aufreißen mittels drehender Werkzeuge (8) erfolgt; und daß das Vermischen des entfernten Materials und der Zuschläge anfänglich mittels der drehenden Werkzeuge (8) und schließlich mittels eines Satzes Mischer (10) erfolgt, welche von einer Seite der bearbeiteten Straße zur anderen hin-und herlaufen.

2. Verfahren nach Anspruch 1, wobei das Aufreißen bis in eine Tiefe von mindestens 8 cm erfolgt.

3. Verfahren nach Anspruch 1, wobei die Decke mittels Sätzen von Heizplatten (1) erhitzt wird, zwischen welche Platten mit isolierenden/reflektierenden Schirmen (17) eingefügt sind.

4. Verfahren nach Anspruch 1, wobei die Kanten der bearbeiteten Straße mittels zweier vertikaler Schneider getrimmt werden.

5. Anlage zum Ausführen eines Verfahrens zum heißen Regenerieren und Wiederaufbereiten von abgenutzten Straßendecken an Ort und Stelle der Art, welche selbstantreibende Einrichtungen zum Erhitzen, Verarbeiten, Planieren und Walzen der Straßendecken umfaßt, dadurch gekennzeichnet, daß sie umfaßt, vorne an der Anlage beginnend: eine erste selbstantreibende Maschine (2), welche ein Tragwerk zum Vorwärtsbewegen und zum Betreiben eines Tanks (3) für brennbares Gas und zweier Sätze Heizplatten (1, 4) darstellt, und eine zweite selbstantreibende Maschine (6), welche ein Tragwerk zum Vorwärtsbewegen und zum Betreiben eines dritten Satzes Heizplatten (5) darstellt, einen Beschickungs-Bodenentleerer (7) für das Zuschlag-Material, ein Reservoir (9) für den Asphaltbeton, einen Tank (20) für brennbares Gas, Aufreißwerkzeuge in der Form von zylindrischen Drehmeißeln (8), einen Satz Mischer (10), die von einer Seite der bearbeitenden Straße zu der anderen hin-und herlaufen, zum Mischen des entfernten Materials mit dem Zuschlag-Material, Teile zum Planieren (11) und zum Walzen (12) der genannten Materialien und einen Beschickungs-Bodenentleerer (7') für das aufrauhende Material, und dadurch, daß der Beschickungs-Bodenentleerer (7) für das Zuschlagmaterial hinter dem Satz Heizplatten (1, 4, 5) und vor den Aufreißwerkzeugen (8) angeordnet ist.

6. Anlage nach Anspruch 5, wobei die Sätze Heizplatten (1, 4, 5) Platten mit Heizelementen umfassen, zwischen die Platten eingeschoben sind, welche keine Heizelemente umfassen und einen isolierenden/reflektierenden Schirm (17) aufweisen, der in einem Abstand von 5 cm vom Boden angeordnet ist.

7. Anlage nach Anspruch 5, wobei die Mischer (10) in einem Satz in zwei parallelen Reihen angeordnet sind, welche jeweils drei bis vier Mischer umfassen und in der Maschinenlaufrichtung ausgerichtet sind, wobei der Satz senkrecht zu der genannten Richtung über die Breite der bearbeiteten Straße hin-und herläuft.

8. Anlage nach Anspruch 7, wobei die Mischer der rechten Reihe (von hinten bezüglich der Maschine gesehen) im Uhrzeigersinn drehen, während die Mischer der linken Reihe im Gegenuhrzeigersinn drehen.

9. Anlage nach Anspruch 5 bis 8, ferner umfassend: zwei vertikale Meißel, die den zylindrischen Meißeln (8) nachgeschaltet sind und mit den vertikalen Kanten der benachbarten nicht bearbeiteten Straßen in Kontakt stehen.

10. Anlage nach Anspruch 5, wobei die erste selbstangetriebene Maschine (2) zwischen dem ersten (1) und dem zweiten (4) Satz Heizplatten angeordnet ist.

Revendications

1. Procédé pour la régénération à chaud et le recyclage in situ de revêtements routiers usés, du type où la couche superficielle dudit revêtement est chauffée par l'intermédiaire d'une source de chaleur et est ensuite scarifiée, et la matière enlevée est ensuite mélangée avec du béton asphaltique, intégrée avec l'addition d'agrégats, mélangée à nouveau au moyen de mélangeurs, nivelée par des rateaux mobiles, comprimée par une barre de damage et finalement damée par roulage, caractérisé en ce que l'addition d'agrégats est effectuée à la fin de la phase de chauffage et avant l'opération de scarification, pour chauffer les agrégats ajoutés par utilisation de l'excès de chaleur sur la surface de revêtement; ladite opération de scarification est effectuée au moyen d'outils rotatifs (8); et l'opération de mélange entre les matières enlevées et les agrégats est effectuée en premier lieu par l'intermédiaire des-

dits outils rotatifs (8) et finalement par l'intermédiaire d'un ensemble de mélangeurs (10) se déplaçant alternativement d'un côté à l'autre de la voie en train d'être travaillée.

2. Procédé selon la revendication 1, dans lequel l'opération de scarification est effectuée jusqu'à une profondeur d'au moins 8 cm.

3. Procédé selon la revendication 1, dans lequel la couche superficielle est chauffée par des ensembles de panneaux chauffants (1), intercalés avec des panneaux comportant un écran isolant/réfléchissant (17).

4. Procédé selon la revendication 1, dans lequel les bords de la voie travaillée sont dressés par deux couteaux verticaux.

5. Installation pour la mise en oeuvre d'un procédé pour la régénération à chaud et le recyclage in situ de revêtements routiers usés, du type se composant de dispositifs auto-propulsés pour le chauffage, le conditionnement, le nivellement et le damage de surfaces routières, caractérisée en ce qu'elle comprend, à partir de l'avant de l'installation, une première machine auto-propulsée (2) formant un support pour déplacer vers l'avant et faire fonctionner un réservoir (3) de gaz combustible et deux ensembles de panneaux chauffants (1, 4), et une seconde machine auto-propulsée (6) formant un support pour déplacer vers l'avant et faire fonctionner un troisième ensemble de panneaux chauffants (5), une trémie (7) de chargement de la matière d'intégration, un récipient pour le béton asphaltique (9), un récipient (20) pour le gaz combustible, des outils de scarification sous la forme d'un couteau cylindrique rotatif (8), un ensemble de mélangeurs (10) servant à mélanger la matière enlevée avec la matière d'intégration et se déplaçant alternativement d'un côté à l'autre de la voie en train d'être travaillée, des éléments pour niveler (11) et damer (12) lesdites matières, et une trémie (7') de chargement de la matière de dégrossissage, et en ce que ladite trémie (7) de chargement de la matière d'intégration est positionnée après les ensembles de panneaux chauffants (1, 4, 5) et avant les outils de scarification (8).

6. Installation selon la revendication 5, dans laquelle lesdits ensembles de panneaux chauffants (1, 4, 5) se composent de panneaux à éléments chauffants intercalés avec des panneaux sans éléments chauffants et pourvus d'un écran isolant/réfléchissant (17) positionné à 5 cm du sol.

7. Installation selon la revendication 5, dans laquelle lesdits mélangeurs (10) sont positionnés dans un ensemble dans deux rangées parallèles, comprenant chacune trois à quatre mélangeurs et orientées dans la direction de déplacement de la machine, ledit ensemble se déplaçant en alternance, perpendiculairement à ladite direction, sur la largeur de la voie en train d'être travaillée.

8. Installation selon la revendication 7, dans laquelle les mélangeurs de la rangée de droite (en regardant depuis le côté arrière de la machine) tournent dans le sens des aiguilles d'une montre tandis que les mélangeurs de la rangée de gauche tournent dans le sens contraire.

9. Installation selon une des revendications 5 à 8, comprenant en outre deux coûteux verticaux, positionnés juste en aval du couteau cylindrique (8) et en contact avec les bords verticaux des voies adjacentes non en train d'être travaillées.

10. Installation selon la revendication 5, dans laquelle ladite première machine auto-propulsée (2) est positionnée entre ledit premier (1) et ledit second (4) ensemble de panneaux chauffants.

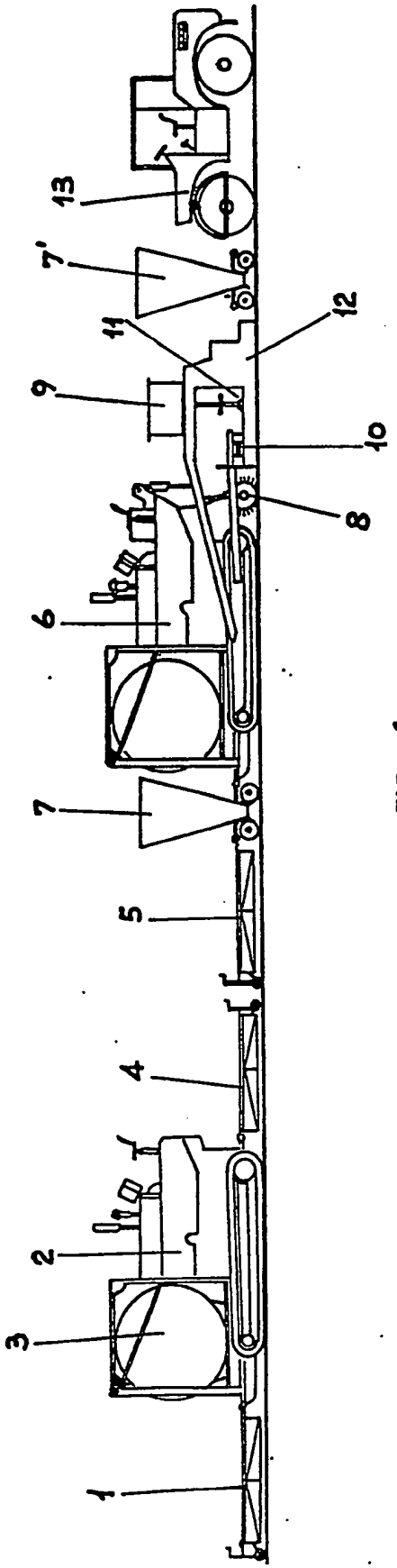

FIG. 1

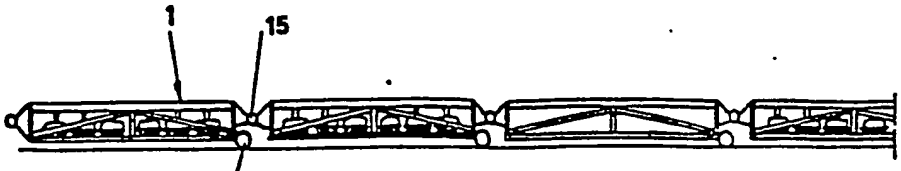

FIG. 2

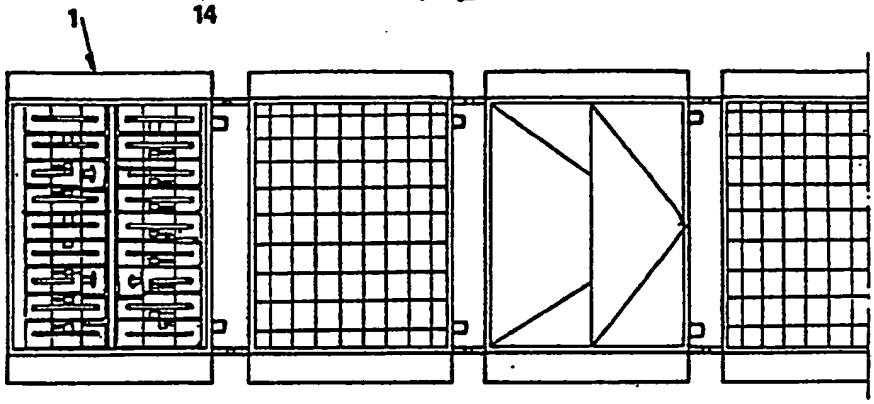

FIG. 3

FIG. 4

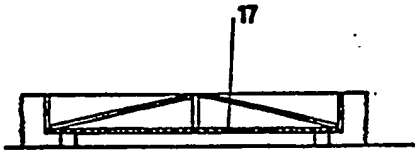

FIG. 5

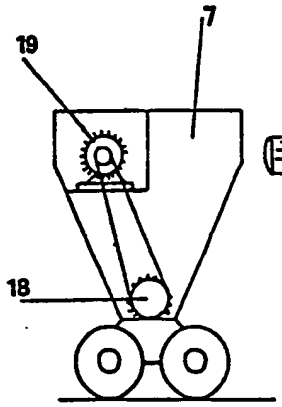

FIG. 6

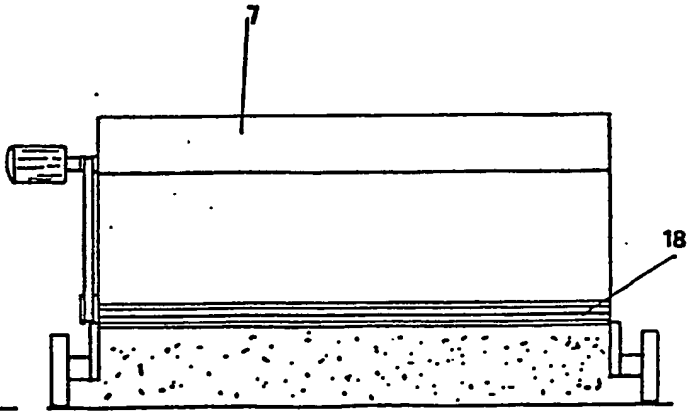

FIG. 7

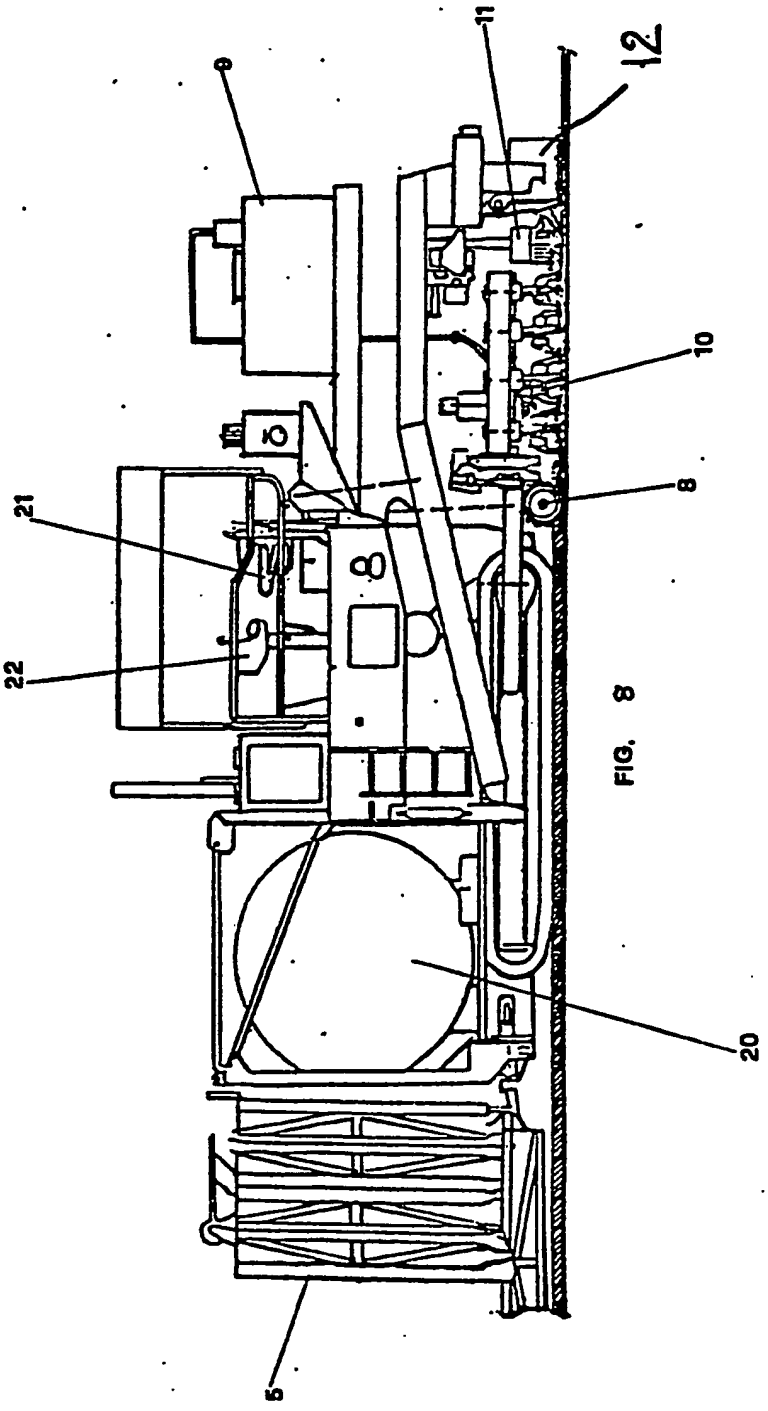

FIG. 8

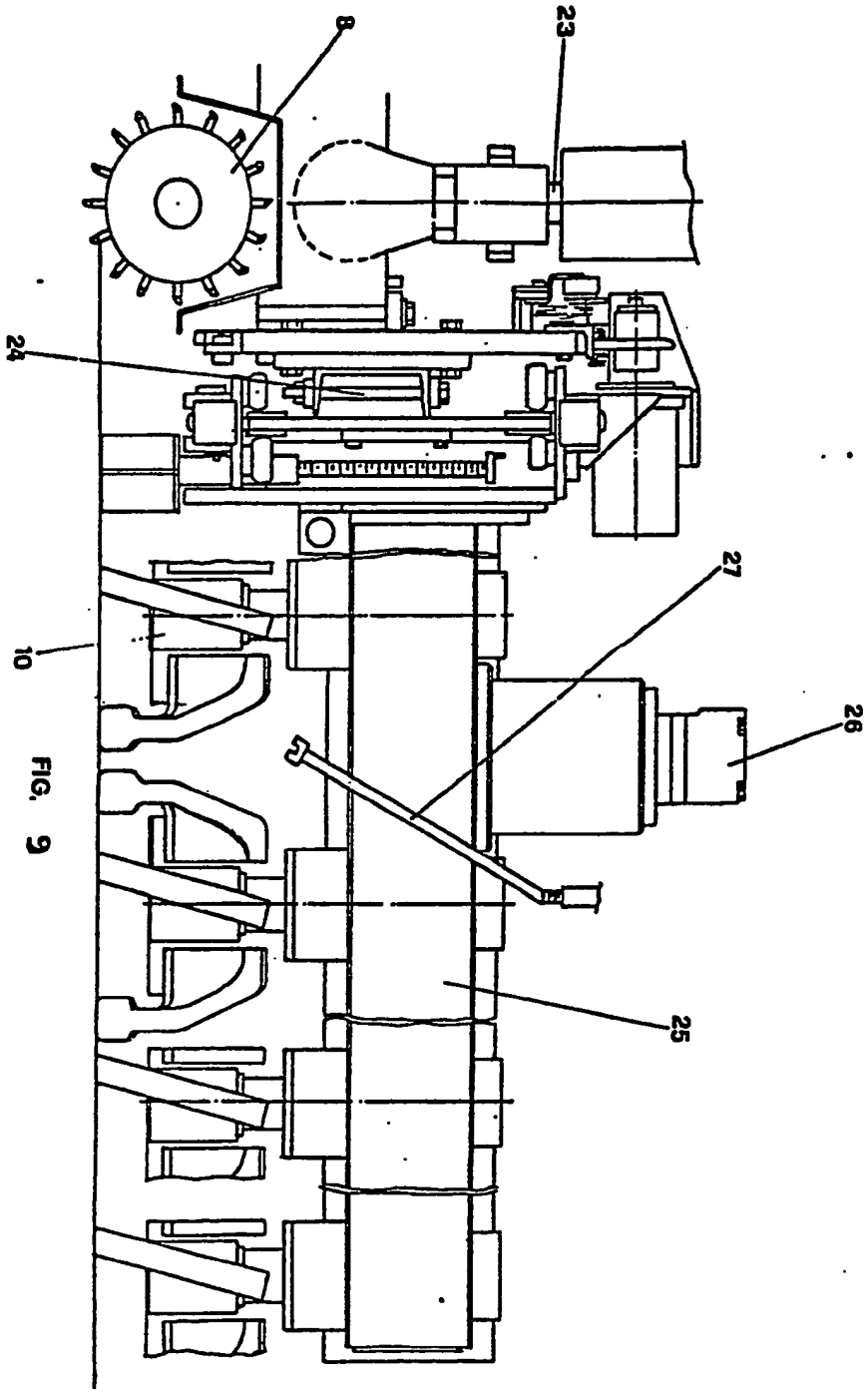

FIG. 9

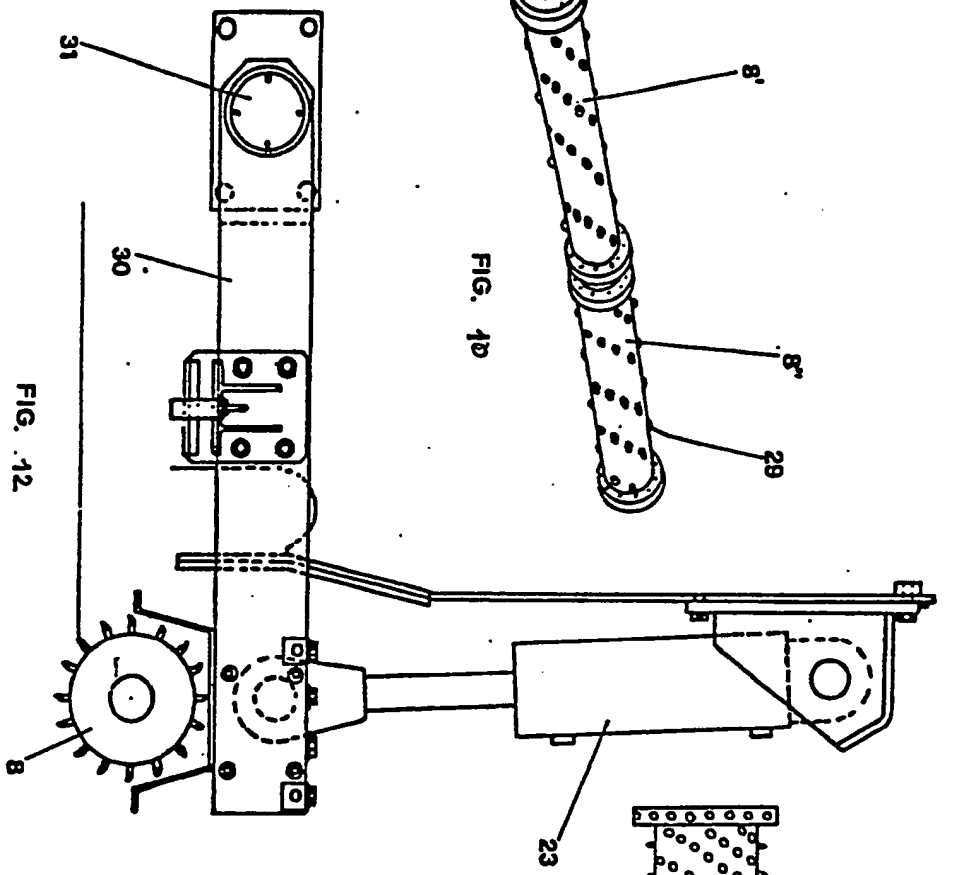

FIG. 12

FIG. 10

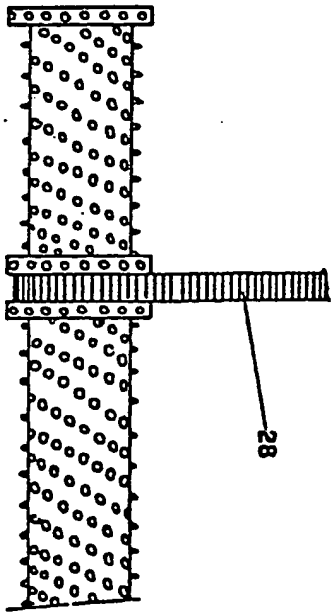

FIG. 11